drogen lines but F are "due to impurities," * so that the hydrogen spectrum is harmonically connected with the corona line.

It may be well to recapitulate, in this connection, some of the simple equations which serve to connect the energies of solar and terrestrial rotation, planetary revolution, atmospheric limitation, molecular oscillation, cosmical aggregation, and æthereal action :

1. $M : \pi r :: v_\lambda : v_r$ Note 34.

2. $v_r = p\, v_h$ Note 34.

3. $v_\lambda = \left(\frac{gt}{2}\right)_0$ Notes 33, 37.

4. $v_0 = p \left(\frac{gt}{2}\right)_3$ Note 17.

See, also, Proc. Am. Phil. Soc., xii, 392–4 ; xix, 21–5, and Note 16.

45. *Cosmical Significance of the Corona Line.*

Earth being the centre of density in the solar system, its nascent locus should have a time of revolution π times as great as its own, with a semi-axis major of $\pi^{\frac{2}{3}} \times 214.45 = 460.002$ solar semi-diameters. The corresponding wave-length (Note 37,) is 5321.35, as is shown by the following proportion :

log. 6441.4 : log. 460.002 : : 7612 : 5321.35.

This differs by less than $\frac{1}{152}$ of one per cent. from the geometric wave-length (Note 41), and by less than $\frac{1}{80}$ of one per cent. from Gibbs's measurement of the corona line.

The Systematic Arrangement of the Order Perissodactyla. By E. D. Cope.

(*Read before the American Philosophical Society, April* 15, 1881.)

PERISSODACTYLA.

This, the second great order of the ungulate Mammalia, naturally occupies a position between the *Amblypoda* and the *Artiodactyla.* Its lower forms are more specialized in the structure of the feet than the *Amblypoda,* while its highest types do not reach the perfection of structure seen in the *Artiodactyla.* This is particularly indicated by the form of the astragalus, which has but one, the tibial trochlea, and never displays the distal one characteristic of the cloven-footed families. The *Perissodactyla* occupy, as regards their dentition, a position parallel with the *Artiodactyla.* They are always superior in dental complication to the *Proboscidia* and the suilline *Artiodactyla,* but only one series, that of the horses, reaches the com-

* Ib. p. 530, foot-note.

plexity of molars general in the *Ruminantia*. The dentition of the mass of the *Perissodactyla* might be described as intermediate between that of the *Proboscidia* and the lowest selenodont *Artiodactyla*.

The families of this order form a closely connected series, and the division of them into three divisions, the "Pachydermata," "Solipeda" and *Perissodactyla*, has no warrant in nature. Especially unnatural is the conjunction of the genera included under the first name, with the *Proboscidia* and certain suilline *Artiodactyla*, in a single order, as was proposed by Cuvier. The modifications of dentition from the simple type seen in *Menodus*, to the most complex, as in *Equus*, are close and consecutive. So, also, the gradual diminution in the number of digits from 5–4 to 1–1 can be traced through all the intervening stages.

The following definitions of families are applicable in the present stage of knowledge. Those of all but three were published in the Bulletin of the U. S. Geological Survey of the Territories, 1879, p. 228. A modification in the diagnoses of the families *Chalicotheriidæ* and *Palæotheriidæ* is now introduced:

I. Anterior exterior crescent of superior molars shortened, not distinguished from the posterior by external ridge; inferior molars with cross-crests; premolars different from molars.

1. Toes 4–3 . . . . *Lophiodontidæ*.
2. Toes 3–3 . . . . *Triplopodidæ*.

II. Exterior crescents of superior molars as in I; inferior molars with cross-crests; superior molars and premolars alike, with cross-crests.

3. Mastoid bone forming part of the external wall of the skull . . . . *Hyracodontidæ*.
4. Mastoid bone excluded from the walls of the skull by the contact of the occipital and squamosal . . . . *Rhinoceridæ*.

III. Exterior crescentoid crests of superior molars subequal, distinct; inferior molars with cross-crests.

5. Superior molars and premolars alike and with cross-crests; toes 4–3 . . . *Tapiridæ*.

IV. The external crescentoid crests of the superior molars subequal, separated by an external ridge; inferior molars with crescents.

A. Superior premolars different from molars; with only one internal cusp.

6. Toes 4-3; a vertebrarterial canal . . . . *Chalicotheriidæ*.
7. Toes 3–3; no vertebrarterial canal . . . . *Macraucheniidæ*.

AA. Premolars like molars, with two internal lobes above.

8. Toes with digits, 4–3 . . . . *Menodontidæ*.
9. Toes with digits, 3–3 . . . . *Palæotheriidæ*.
10. Toes with digits, 1–1 . . . . *Equidæ*.

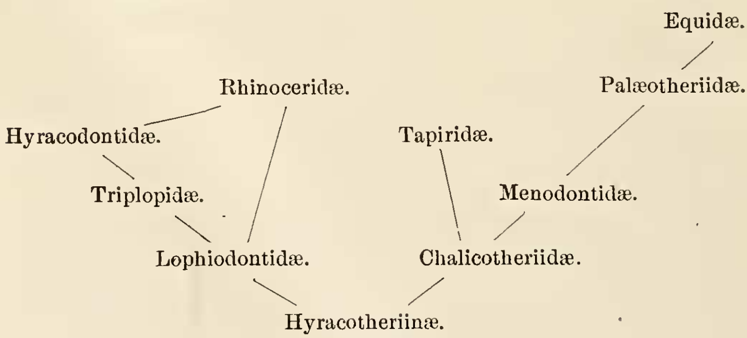
The genera included in these families are the following. The table shows their geological distribution :

	Eocene.		Miocene.			Pliocene.	Recent.
	Lower	Upper	Lower	Middle	Upper		
Lophiodontidæ.							
Hyracotherium Ow.	12						
Pliolophus Ow.	4	2					
? Lophiotherium Gerv.		1					
Pachynolophus Pom.	3	3					
Helaletes Marsh		3					
Lophiodon Cuv.	2	11					
Hyrachyus Leidy		9					
Colonoceras Marsh		1					
Triplopidæ.							
Triplopus Cope		2					
Hyracodontidæ.							
Hyracodon Leidy			2				
Rhinocerontidæ.							
Aceratherium Kaup			3				
Cœnopus Cope			2				
Diceratherium Marsh				3			
Zalabis Cope							
Aphelops Cope					4		
Ceratorhinus Gray				1	2		2
Rhinocerus Linn.					4		2
Peraceras Cope					2		
Atelodus Pom.					2	1	2
Cœlodonta Bronn						3	
Tapiridæ.							
Listriodon Gerv.				? 3			
Tapirus Linn.						6	5
Elasmognathus Gill							1
Chalicotheriidæ.							
Rhagatherium Pict.	1						
Leurocephalus S. S. and O.		1					
Palæosyops Leidy	1	5					
Limnohyus Leidy		3					
Lambdotherium Cope	2	1					
Propalæotherium Gerv.	1	2					
Chalicotherium Kaup.		3					
Nestoritherium Kaup				? 1			
Meniscotherium Cope	1						
Macraucheniidæ.							
Macrauchenia Ow.					2		

	EOCENE. Lower	EOCENE. Upper	MIOCENE. Lower	MIOCENE. Middle	MIOCENE. Upper	PLIOCENE.	RECENT.
Menodontidæ.							
Acoëssus Cope	1						
Diplacodon Marsh		1					
Menodus Pom			2				
Symborodon Cope			6				
Dæodon Cope				1			
Palæotheriidæ.							
Anchilophus Gerv		2					
Paloplotherium Ow		6					
Palæotherium Cuv		3					
Mesohippus Marsh			2				
Anchitherium Kaup			2	4			
Anchippus Leidy				1	1		
Hippotherium Kaup					8	1	
Protohippus Leidy					5	1	
Equidæ.							
Hippidium Owen					2	3	
Equus Linn						5	7

Total number of well determined species, one hundred and eighty-nine.

From the preceding table it can be readily seen that this order was abundantly represented during the Eocene period, and that the recent species are comparatively few. It may also be observed that certain families predominated during certain periods. Thus the prevalent *Perissodactyla* of the Eocene are *Lophiodontidæ* and *Chalicotheriidæ;* those of the Miocene are *Rhinocerontidæ* and *Palæotheriidæ.* The *Tapiridæ* and *Equidæ* characterize the latest tertiary epochs. A genealogical tree of the order may be constructed as follows :



The types of the *Lophiodontidæ* and *Chalicotheriidæ* differ only in the two points of the separation, or non-separation, of the exterior crescents of the superior molars, as already pointed out. That no great modification of known forms (as *Lambdotherium* in the *Chalicotheriidæ*, and *Hyracotherium* in the *Lophiodontidæ*) would be necessary to obliterate this difference, is quite clear. The parent types of the order, which present the most generalized dentition, *Hyracotherium, Rhagatherium,* and *Acoëssus,* were cotemporaries of the Lower Eocene epoch.

LOPHIODONTIDÆ.

This family embraces a larger number of known species than any of the others of the order. With one exception, all the species belong to the Eocene period. They range from the size of a rabbit to that of an ox. They resembled most, among living animals, the tapirs.

The genera are characterized as follows :—

I. External lobes of superior molars well separated and little flattened ; lobes of inferior molars scarcely united (*Hyracotheriinæ*).

A. No diastema behind first premolar.

a. Third and fourth inferior premolar like the first true molar.

Last inferior molar with five lobes .... *Lophiotherium.*

AA. A diastema behind the first premolar in both jaws.

a. Last inferior premolar different from first true molar ;

Last inferior molar with heel ; cross-crests of superior molars interrupted ; *Hyracotherium.*

aa. Last inferior premolar like first true molar ;

True molars as in *Hyracotherium* .... *Pliolophus.*

II. External lobes of superior molars flat, not well distinguished. (*Lophiodontinæ.*)

"*A*. No diastema in lower jaw.

Last inferior molar with third lobe .... *Helaletes.*"

AA. Lower jaw with diastema.

*No diastema behind first premolar.

a. No inferior premolars like the true molars.

Superior molars 7.

Last inferior molar with heel .... *Pachynolophus.*

Superior molars 6 ;

Last inferior molar with heel.................................. *Lophiodon.*

Last lower molar without heels, no horns .... *Hyrachyus.*

Last lower molar? ; "an attachment for a dermal horn on each nasal bone" .... *Colonoceras.*

The geographical range of these genera is as follows :—

North America only......... .... *Helaletes, Colonoceras.*

North America and Europe ; *Pachynolophus, Hyrachyus, Hyracotherium, Pliolophus.*

Europe only ; *Lophiodon, Lophiotherium.*

Four of the genera ascribed to North America have come under my observation.

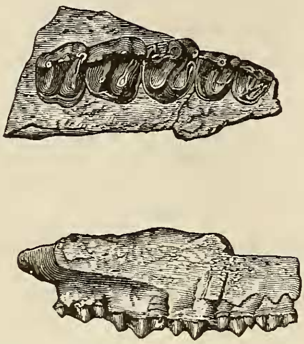


Fig. 1. Part of right maxillary bone of *Pachynolophus singularis* Cope ; from the Wasatch beds of New Mexico, from Capt. Wheeler's report iv ii pl. lxvi.

TRIPLOPIDÆ.

Cope, American Naturalist, 1881, April (March 25th), p. 340.

But one genus of this family is known at present, but the number will probably be increased when the structure of the feet of various imperfectly known species is ascertained.

TRIPLOPUS Cope.

American Naturalist, 1880, p. 383 (April 27th).

Dental formula, I. ? ; C. $\frac{1}{1}$; P–m. ; $\frac{4}{4}$; M. $\frac{3}{3}$; a considerable diastema anterior to the first premolar. Molars with only two vertical external ridges, the anterior cingular and the approximated median of the anterior crescent. Transverse crests two, uninterrupted and rather oblique ; a ? third and short crest, on the posterior base of the first true molar. Premolars different from molars, the third and fourth with two transverse crests. Inferior molars with two transverse crests, as in *Lophiodon,* the last without heel.

An ossified inferior wall of the meatus auditorius externus. Posttympanic and paroccipital processes distinct form each other. No postorbital arch. Postparietal and mastoid foramina preserved ; the latter large. Cervical vertebræ rather long ; axis with subcylindric odontoid process. Scapula with small coronoid process. Great tuberosity of humerus long, curved. No trochlear crest on condyles of humerus ; epicondyles rudimental. Ulna and radius distinct throughout their length ; ulnar articulation with carpus, small. Trapezoid bone of carpus with a facet for the trapezium. Unciform with two inferior facets. Metacarpals three principal ones, and one, the fifth, rudimental ; the distal extremities of the second and fifth opposite ; the third a little longer.

The dentition of this genus is nearly that of *Hyrachyus.* The only exception is the possible third transverse crest of the first true molars*. The other portions of the skeleton known, are also much like those of *Hyrachyus,* with the exception of the number of digits of the anterior foot. The entirely rudimental character of the fifth metacarpal, which with its

* This point is further considered in the description of the species.

digit, is so well developed in *Hyrachyus*, places *Triplopus* in another family, and in another line of descent. I think that it must be regarded as one of the forms of the series connecting the tapirs with the rhinoceroses. The fourth digit (the fifth) was retained by the earliest type of rhinoceros in Europe, the genus *Aceratherium*, but in America it appears to have been lost earlier. None of the American rhinoceroses of the Lower Miocene of the genus *Cænopus* Cope present it, and in the present genus we have an ancestral type of the Eocene period, in which the last digit is already lost. The premolars of different structure from the true molars, exclude this genus from the *Rhinocerontidæ*, and with the character of the feet place it between that family and the *Lophiodontidæ*.

As yet, but one species of *Triplopus* is certainly known, but a second is placed in it provisionally.

TRIPLOPUS CUBITALIS Cope.

American Naturalist, 1880, p. 383.

This species is represented by a nearly entire skull with lower jaw; most of the cervical vertebræ; a left anterior limb nearly complete; a part of the left scapula, and a part of the right anterior limb; all belonging to one animal. The specimen was not quite adult, as the last superior molar is just protruding its crown through the maxillary wall, and the last two superior milk premolars still remain in place, much worn and closely pressed by the overlying successional teeth.

The *cranium* is peculiar in its wide orbital region, and short compressed muzzle; the latter is damaged in the specimen so that the form of the nasal bones cannot be determined, except at their proximal portions. The interorbital space is plane in both directions, and rises very gently posteriorly. The sagittal crest is narrow and low, until above the meatus auditorius, where it rises. Above the posttympanic process it bifurcates, and each rounded lateral lobe extends posteriorly to a point above the occipital condyles. Viewed from above the head is wide between the zygomatic fossæ, and at the posterior premaxillary teeth. The top of the muzzle narrows rapidly above the latter, but does not contract below until the first premolar is reached. The zygomatic arch is not convex along its middle, and encloses a narrow fossa. The superciliary border is prominent, and nearly straight, and is bounded by a notch behind. The squamoso-occipital ridge is well marked. The posttympanic process is shorter than the paroccipital, and is separated from it by an open shallow groove, which is probably bottomed by the mastoid bone. The paroccipital process is much narrowed below and is turned a little outwards. There are two closely adjacent tubercles on the anterior border of the orbit, probably on the lachrymal bone.

Foramina. Only a few of these are well preserved; among the lost is the *f. infraorbitale*. There are two postparietal foramina on one side, and one on the other, above the point of origin of the zygomatic process of the squamosal bone; and one in the usual posterior position. The post-squamosal has the same anterior position as the anterior postparietals, being immediately below them ; I cannot discover whether there is a posterior one or not owing to injuries to the specimen. There is apparently a fissure-like one on the parieto-squamosal suture posteriorly. The mastoid is quite large, expanding downwards and outwards ; it is not so large as in a tapir, but much exceeds that in *Hyrachyus eximius.* The *meatus auditorius externus* is large, and occupies only the posterior part of the space between the postglenoid and posttympanic processes. It is enclosed anteriorly and below by the border of a wide element which may be tympanic. It encloses the petrous bone below in a bulla ; as however the inner portion of the best preserved one is broken away, I cannot speak of its relations to the basioccipital bone. The *foramen lacerum posterius* is reduced to a jugular and perhaps another connected foramen by the close apposition of the petrous bone to the basioccipital for a considerable distance. The region of the *f. l. medius* is injured. Posterior to the *f. l. posterius* is a foramen opposite the base of the paroccipital process, anterior to the usual position of the *f. condyloideum.*

Mandible. The angle of the lower jaw is produced posteriorly, as in some species of *Hyrachyus:* cfr. figs. Vol. IV, U. S. Geol. Surv. Terrs. The coronoid process is long and is curved backwards to above the posterior border of the condyle. There is no tuberosity behind the condyle. The symphysis is quite contracted and is short. The mental foramen is below the middle of the inferior diastema. The ramus is compressed and at the same time strong.

Dentition. As the deciduous third and fourth premolar teeth, in a worn condition, remained in the maxillary bone, I removed them from one side, thus displaying the crowns of the corresponding permanent teeth. The first premolar may belong to the permanent dentition ; the second is the deciduous. The former has two roots. The crown is cutting for a short distance anteriorly, but posteriorly it expands into a heel, much less developed than the internal lobe of the succeeding teeth. The crowns of the third and fourth premolars differ externally, as well as in their crests, from those of the true molars. The median-anterior and cingular vertical ridges are not so prominent as in the latter. The external crest is not divided into two by the notch in its grinding face. The anterior cross-crest, at its inner or distal extremity, is turned shortly backwards and then inwards, giving a "pot-hook" outline to its triturating surface. The fourth deciduous premolar presents a peculiar character already ascribed to the first true molar. This consists of a crest running parallel with the posterior transverse crest and close to it, along its posterior side. It forms the border of the tooth for a short distance, but as its direction is slightly obliquely forwards as well as outwards, the posterior cingulum appears for a very short distance.

The first true molar is subquadrate in outline. The anterior transverse crest commences at the middle anterior ridge, and is first transverse, then directed a little obliquely backwards. The second crest commences at the apex of the posterior external crescent, leaving a wide posterior marginal fossa. Its internal extremity is broken off. Posterior to, and in contact with it, the posterior cingulum rises in a crest, which occupies the internal half only of the border. Its inner border is imperfect. It appears to me to be probable that the normal posterior crest is turned posteriorly on itself so as to give the "pot hook" shape seen in the anterior crest of the fourth permanent premolar. The corresponding accessory crest in the fourth temporary premolar appears to have been distinct at its internal extremity. The second true molar has a more oblique posterior external crest, and the posterior internal is oblique and simple. It has narrow anterior and posterior basal cingula. There is no tubercle between the inner bases of the transverse crests of this or the last true molar. The latter is characterized by the rudimental character of the posterior external crescent crest, which is shortened like that of *Hyrachyus*. The transverse crests are curved backwards; the posterior is short and simple.

The canines are small, and are directed forwards. The extremity of the muzzle being broken, the relation of the incisors cannot be stated, but there was not probably any precanine diastema. An incisor preserved has the crown transversely expanded, and rather oblique.

The third and fourth inferior premolars are the deciduous ones, and are both three-lobed, but differ in the forms of the anterior lobe. In the third, it is narrow and incurved, as in the corresponding permanent teeth of some *Artiodactyla*. The transverse crests of the true molars are rather oblique, running forwards as well as outwards.

Their external extremities are bent at right angles, and there results a short descending crest running forwards and inwards; the anterior one turns inwards, again forming a transverse anterior ledge. No cingula on internal or external bases of crown; a rudimental posterior one.

Measurements of Cranium.	M.
Length from front of canine tooth to end of occipital condyles	.128
Length from same to postglenoid process	.096
" " " to end of last molar	.069
" " " to first premolar	.015
" " " to line of front of orbit	.044
Width between superciliary borders	.046
" of zygomata at orbits	.064
" of brain-case at glenoid surface	.048
" of occipital condyles	.023
" of basioccipital bone between *ossa petrosa*	.006
Distance between postglenoid and posttympanic processes	.014
Depth of occiput behind	.033
" of mandible from condyle	.040
" of mandibular ramus at third premolar	.014
" at diastema (axial)	.009
Least width of symphysis	.011

Measurements of Cranium.

		M.
Diameter crown third permanent premolar	anteroposterior...	.007
	transverse.	.005
Anteroposterior diameter crown first premolar.........		.0045
Diameters crown first true molar	anteroposterior.....	.010
	transverse	.012
Diameters crown second inferior true molar	anteroposterior	.011
	transverse.	.0075
Diameter of root of inferior canine near crown.........		.0035

Vertebræ. The atlas is about as long relatively as that of the horse. Its transverse processes have more anteroposterior than transverse extent. The summit of the neural arch has a median ridge separating two grooves. The inferior surface of the centrum has a nearly median, obtuse hypapophysis. The axial facets are well separated below. The vertebrarterial canal pierces the base of the transverse process behind and below, and notches it deeply anteriorly. Above this notch the usual perforation of the arch is present. The axis is not relatively quite so long as that of the horse; it is a little longer than in *Hyrachyus eximius*, but rather shorter than in *Hyracodon arcidens* (Pl. CII, Fig. 7). The atlantal facets are spread well apart, and the articulating surface of the odontoid does not connect with them. The latter is rather long, is obtuse, and slightly recurved; it has no raised borders. Between the atlantal faces the inferior surface is plane. Posterior to this the middle line bears a prominent keel. The diapophyses are long, narrow and recurved, and each is pierced at the base by the vertebrarterial canal. The posterior articular face is but little concave, and a little oblique, and is a little wider than long.

The succeeding cervicals regularly diminish in length, and become more strongly opisthocœlous, the seventh having quite a ball in front. The sixth has a slender diapophysis directed posteriorly, and quite distinct from the wide and long parapophysis which is directed downwards and outwards. The posterior angle of the latter extends as far back as the centrum. The seventh has only a flat transverse diapophysis. The first dorsal has a very stout diapophysis excavated below for the rib tubercle. The diapophyses of the third and fourth dorsals are not so stout. The capitular fossæ are large. The centra of the anterior dorsals are flattened below; they are concealed in part by the matrix in this specimen. The neural spine of the sixth cervical is narrow, and is directed forwards. That of the seventh is vertical, and narrows rapidly from a base which is rather wide anteroposteriorly. The spines of the dorsals are wider, and are directed gently posteriorly; they are probably long, judging from the size of their bases.

Measurements of Vertebræ.

	M.
Length centrum of atlas on side......................	.027
" " " below......................	.010
Width " " " posteriorly	.030

Measurements of Vertebræ.			M.
Width transverse process of atlas			.010
Vertical diameter neural and odontoid canal			.015
Length axis to odontoid process			.033
" odontoid process			.007
Diam. centrum behind	vertical	with hypapophysis	.012
		without "	.009
	transverse		.0115
Length of centrum of fifth cervical			.030
" " seventh			.017
" " second dorsal			.014
Anteroposterior diameter of base of neural spine of second dorsal			.010
Expanse of head and tubercle of first rib			.012

Fore Limb.—The greater part of the blade of the scapula is lost. The neck is stout, and the coracoid is a short aliform process. The humerus is moderately robust, most so proximally. The greater tuberosity is a strongly incurved crest, with truncate summit, which is a little elevated above the plane of the head, from which it rises rather abruptly. The bicipital ridges are not strong nor prominent. The olecranar fossa is deeper than the coronoid fossa, and they communicate by perforation. The inner part of the condyle is the largest, and forms an acute angle with the interior epicondylar surface. The exterior part of the condyle is divided by an oblique angle of the surface separating an external bevelled band of the same, which narrows to extinction on the posterior side. As compared with the humerus of *Hyrachyus eximius*, that of *Triplopus cubitalis* is very similar, differing mainly in two points at the distal extremity. The olecranar fossa is smaller and is less excavated, and its lateral bounding ridges are of unequal elevation ; in *T. cubitalis* they are equal.

The ulna and radius are more than one-fourth longer than those of *H. eximius*. Although they are entirely distinct throughout, the ulna is quite slender anterior to the proximal third. The shaft is much more slender than that of *Hyrachyus eximius*. The olecranon is compressed, deep, and truncate behind. The distal epiphysis is remarkable for its length, being twice as long as that of the radius. The head of the radius is subequally divided by fossæ, the external being the shallower. The inferior or ulnar facet is regularly and gently convex downwards, and is bounded behind by a roughened ridge, which, near the external border turns backwards to the humeral border. The shaft of the radius is robust and flattened. The carpal facet of the radius is contracted, and has three times the superficial area of that of the ulna. The scapholunar dividing ridge is present, but is very low. The scaphoid face is the more excavated, and then rolls backwards, forming a very narrow posterior facet, which is narrower than that found in the species of *Anchitherium*. There is no distinct fossa on its inner or posterior border, as in many ungulates. The trapezium and scaphoid are the only bones of the carpus which are wanting. The latter is probably wider than long or deep, while both the lunar and cuneiform are longer than wide. The cuneiform has not its external border excavated; its proximal surface is oblique and continuous, the ulnar and pisiform facets being in line. The pisiform is large, and is enlarged distally; its proximal facets are equal. The exposed face of the trapezoides is rather larger than that of the magnum, and is nearly as large as its own face of contact with the latter. The magnum has the usual great anteroposterior extension, with elevated posterior convexity applied to the fossa of the lunar. Its posterior process is long, nearly equal to the rest of the bone, and is depressed and flattened distally. The metacarpal facet is very concave. The unciform's anterior or exposed face is a little longer than wide. Its two proximal facets are about equal. It is about as deep as wide, and extends half its length distad to the magnum. Its posterior process is rather narrow; it is narrow and abruptly decurved. Distally, the facet for the fifth metacarpal is well marked, and has about half the area of that for the fourth metacarpal. The functional metacarpals are of moderate length as compared with the elongation of the ulnoradius. The third is largely in contact proximally with the unciform as well as with the magnum. The condyles are stout, and each is laterally impressed by a fossa. The second and fourth have chiefly lateral presentation, but are not much narrower in the shaft than the median metacarpal. The first phalange of the lateral digit is a little shorter than that of the median, while the seconds are of equal length. The extremity of the second digit reaches the proximal third of the length of the median ungual phalange. The fissure of the ungual phalange reaches the middle of its length. The fifth metatarsal is proximally rather stout; but it soon contracts to a thin rounded extremity, at only one-fifth the length of the fourth.

Measurements of Fore Limb.	M.
Antero-posterior diameter of cotyloid cavity of scapula	.015
Diameter of head of humerus { transverse	.020
" " { anteroposterior	.019
" with greater tuberosity	.030
Length of humerus on outer side	.110
Diameter humerus at epicondyles { transverse	.021
" " { anteroposterior externally	.015
Length of ulna	.165
" radius	.141
Depth of olecranon distally	.015
Width of ulna at coronoid	.015
" " carpal facet (greatest)	.007
" radius at head	.016
" " carpal facets	.014
" " widest point distally	.016
Length of carpus at magnum	.015
" " unciform	.018

Measurements of Fore Limb.

		M.
Length of lunar		.010
Depth "		.011
Length of magnum		.005
Depth "		.017
Length unciform		.009
Width "		.009
Depth " (total)		.014
" " of inferior facets		.007
Length of third metacarpal		.068
Proximal diameter third metacarpal	anteroposterior	.008
	transverse	.008
Length of fifth metacarpal		.012
" median series of phalanges		.027
" first median phalange		.010
Width of do. proximally		.008
Length of second phalange		.006
Widths of median ungual phalange	proximally	.0070
	medially	.0055
	greatest	.007

The body of this animal was about the size of that of a red fox. The legs were more slender or elevated, and the head of course was shorter and thick.

The unique specimen on which our knowledge of this species rests was cut from a block of calcareous sandstone of the bed of the Washakie basin of the Bridger Epoch, near South Bitter creek, Wyoming Territory. The bones are generally in the relation of the position in which the animal died. The neck is depressed and the left fore leg raised so as to be in contact with it, and the head is raised so as to clear the left wrist.

Triplopus amarorum Cope.

The characters of the fore-foot of this species being unknown, it is not possible to determine its generic position. It has, however, one of the well-marked characteristics of the genus *Triplopus*, in the osseous enclosure of the *meatus auditorius externus*, through the ossification of the external prolongation of the otic bulla, and tympanic cartilage. I cannot therefore refer it to *Hyrachyus*.

It is represented by a skull from which a large part of both maxillary bones and the mandible have been lost, and which is accompanied by parts of the ulna and radius, parts of the ilium, a femur, and tibia, and nearly all of the posterior foot of the right side. The posterior parts of both maxillary bones remain, and they support each, the last superior molar tooth from which the external wall has been broken away. The portions of molars remaining exhibit characters which lead me to suspect that the species does not belong to *Hyrachyus*. The anterior cross-crest of the molar preserved, is lobate, resembling the same ridge in the species of *Anchitherium*. The posterior cross-crest is uninterrupted. If this species possesses affinity with *Anchitherium*, it will perhaps possess three digits of the manus, in which case it will be referred to the *Triplopidæ*, in harmony with the indication furnished by the ear structure.

The *Triplopus amarorum* is much larger than the *T. cubitalis*, equalling the *Hyracodon nebrascensis*. It differs from the *T. cubitalis* in the stronger temporal ridges, and more elevated sagittal crest; also, in the shorter post-tympanic process. The internal lobes of the last superior molar are connected by a basal ledge, not found in the *T. cubitalis*.

The interorbital space is wide and flat, and is most expanded at the postorbital angles.

From this point the face contracts rapidly forwards. From the same angle it contracts abruptly posteriorly to the rather narrow brain-case. The anterior temporal ridges are nearly transverse near the postorbital processes, and then converge more gradually, uniting opposite the posterior inferior border of the zygomatic fossa. The elevated sagittal crest diverges into two lateral supraoccipital crests, which contract as they descend, and continue to the extremities of the posttympanic processes. Although the postorbital angles are prominent, they cannot be called processes. The paroccipital processes are large, and are directed vertically downwards. They are separated by the usual concavity from the occipital condyles. The posttympanics are very short, forming only an angle projecting downwards at the anterior base of the paroccipitals, from which they are only separated by a notch. The inferior side of the tympanic bone is flat near the meatus, but opposite the stylomastoid fossa its posterior border is turned forwards, and is produced into a well marked process. It encloses a groove in front of it, which is continuous with the pterygoid fossa. The petrous bone is not inflated, and its inferior surface is divided into two longitudinal ridges. The inner is the less prominent, and is in close contact with the basioccipital. The postglenoid processes are robust and obtuse. The basioccipital is excavated in front of each of the condyles. The inferior surface is nearly flat, with a slight median keel. The pterygoid fossa is well defined, and is long and narrow. The posterior nareal trough is elongate, the descending pterygoid processes of the sphenoid originating as far back as the apex of the *os petrosum*. This species is especially characterized by the presence of an acute keel-like ridge, which extends horizontally above the foramina sphenoörbitale and opticum, and turns upwards anterior to the latter, terminating a half inch below the inferior base of the postorbital process. All the foramina are below it, but there is a fossa above it, opposite the interspace between the *f. opticum* and *f. sphenoörbitale*.

A supraorbital foramen pierces the frontal bone, a quarter of an inch within the superciliary border. There are five or six postparietal foramina, two of which are nearly on the squamosal suture. There is a postsquamosal foramen, and also a not very small supraglenoid foramen. There is a small foramen anterior to the optic, and in line with the posterior part of the postfrontal angle. The *foramen opticum* is large, and is 10mm. in front of the *f. sphenoörbitale.* The latter is separated by a lamina from the large and vertically oval *f. rotundum.* The latter is joined by the large alisphenoid canal, whose posterior orifice is as large as the foramen ovale. The latter is large, and is well separated from the *f. lacerum anterius.* The *f. f. lacera* are well closed up, the *posterius* being reduced to what is probably the jugular foramen. The *f. condyloideum* is large, and is an anteroposteriorly placed oval. Its anterior extremity is opposite to and well separated from the *f. jugulare.*

The nasal bones are spread out posteriorly, and their posterior extremities are truncate. The coronal suture passes downwards at the narrowest part of the cranium behind the postfrontal angles. The squamosal bone does not reach the frontal. The parietal does not extend so far posteriorly as the lateral occipital crests, except near the squamosal.

The characters of the last superior molars have already been mentioned. The posterior transverse crest is uninterrupted, but the anterior consists of closely united internal and median lobes. The division is marked on the posterior side, and on the edge of the crest; the anterior face is plane. The longitudinal external crest sends a strong protuberance into the head of the valley, which is grooved on its surface. There is a strong anterior basal cingulum which rises to an anterior cusp. On numerous surfaces the enamel is slightly rugose. The inferior canine teeth are in continuous series with the incisors, and are slightly larger than they.

Measurements of Skull.		M.
Length from line connecting anterior borders of orbits to occipital crest		0.132
Length from line connecting posterior borders of orbits to occipital crest		.100
Width between postorbital angles		.100
" " anterior borders of orbits		.076
Elevation of occiput		.065
Width between mastoid ridges		.065
" " *ossa petrosa* at middle		.018
Diameters third superior true molar	anteroposterior	.0200
	transverse	.0205
Diam. second superior true molar (base)	anteroposterior	.0200
	transverse	.0150

The portion of ilium remaining exhibits a rather narrow neck and a concave external face. A fragment of the femur shows a prominent third trochanter, with an obtusely rounded apex. The distal part of the fibula is not coössified with the tibia. Its shaft is exceedingly slender. The angles bounding the trochlear grooves and ridges of the tibia are of sub-equal lengths. The median ridge is rather wide ; the inner malleolus is narrow, has no distal facets and no distinct tendinous grooves externally.

The posterior foot is both relatively and absolutely smaller than that of *Hyrachyus eximius*. The trochlea of the astragalus is narrower and more deeply grooved. The crests are obtuse, and not so narrowed as in *Mesohippus bairdi*, nor are the malleolar facets of the astragalus so sharply defined as in the latter species. The external ligamentous fossa is, however, deep, and is bounded anteriorly by a low trihedral tuberosity not found in the *M. bairdi*. The head of the astragalus is not sessile as in *M. bairdi*, and has rather the proportions of *H. eximius*. The cuboid facet is a bevel of the external side of the distal extremity, as in *H. eximius*, and is not on a produced ledge, as in *M. bairdi*. The internal tuberosity of the head is not as much developed as in either of the species named. The navicular face of the astragalus is horizontally divided by a shallow ligamentous fossa. The calcaneum is much like that of *Hyrachyus eximius*. The cuboid face is less oblique than in that species, in the anteroposterior direction, and is less crescentic in outline than in *M. bairdi*. The sustentaculum is rather more extended transversely than in *H. eximius*, but resembles that species more than the *M. bairdi*, in wanting the deep groove at its base on the inferior side, which cuts it off from the rest of the calcaneum. The remainder of the inferior surface is flat, and not grooved for a tendon as in *H. eximius*.

The remainder of the tarsus includes the usual five bones, the three cuneiforms being present. They are in general a good deal like the corresponding bone of *Hyrachyus eximius*. The navicular differs in having a low transverse ridge on its proximal face, which fits the groove of the astragalus already mentioned. The hook of the cuboid is large. The external (anterior) face of the mesocuneiform has one-third the superficial area of the anterior face of the ectocuneiform. The entocuneiform is rather large, and is flat and subsemicircular. Its position is externo-posterior. The ectocuneiform presents facets to both the second and fourth metatarsals, that with the latter the largest. The distal halves of the metatarsals are lost. At their proximal portions they are of subequal width, as in *Hyrachyus eximius*, but the lateral ones are rather narrower at the middles of the shafts.

Measurements.	M.
Width of distal extremity of tibia	.029
" astragalar face "	.019
Length of inner malleolus	.007
" astragalus on inner side	.030
Depth of trochlea " "	.017
" head " "	.0145
Width of trochlea	.015
" navicular facet	.0195
Length of head from inner crest of trochlea	.005
" calcaneum	.058

Measurements.		M.
Length of free part of calcaneum		.037
Distal depth of the calcaneum		.016
Diameters cuboid face calcaneum	anteroposterior	.0145
	transverse	.0145
Length of navicular		.008
" cuboid		.0145
Transverse proximal width of three metatarsals		.027
Diameters of second metatarsal	anteroposterior	.014
	transverse	.007
Antero-posterior diameter of third metatarsal		.0145
Diameters of fourth metatarsal	anteroposterior	.014
	transverse	.012

This species was obtained in 1873 from the bad lands of South Bitter creek, Wyoming, from the Washakie basin of the Bridger formation. The locality is the same as that which furnished the *Triplopus cubitalis*, the *Achænodon insolens*, etc.

HYRACODONTIDÆ.

This family, which I characterized in 1879, includes, so far as yet known, the single genus *Hyracodon*, which is found in the Oligocene White river formation of North America. According to Marsh, the digits of this genus number three on both anterior and posterior limbs. It has a full series of incisor teeth in both jaws.

RHINOCERIDÆ.

This extensive family has left representatives in all parts of the Northern Hemisphere, and species still exist in the Old World. From the following table the range of variation of its genera can be readily seen :

I. Four anterior digits.

Incisors $\frac{2}{1}$; canine $\frac{0}{1}$; no horn ; posttympanic bone distinct. *Aceratherium.*

II. Three anterior digits.

a. Posttympanic process not coössified with postglenoid.

Incisors $\frac{2}{1}$; canines $\frac{0}{1}$; no dermal horn . . . . *Cœnopus.*

Incisors $\frac{1}{1}$; canines $\frac{0}{1}$; no dermal horn . . . . *Aphelops.*

Incisors $\frac{0}{1}$; canines $\frac{0}{1}$; no dermal horn . . . . *Peraceras.*

Incisors $\frac{1}{1}$; canines $\frac{0}{1}$; a tuberosity for a dermal horn on each nasal bone. *Diceratherium.*

Incisors $\frac{1}{1}$; canines $\frac{0}{1}$; a median dermal nasal horn . . . . *Ceratorhinus.*

Incisors $\frac{3}{2}$; canines $\frac{0}{1}$ . . . . *Zalabis.*

Incisors $\frac{0}{0}$; canines $\frac{0}{0}$; dermal horn median ; no osseous nasal septum . . . . *Atelodus.*

aa. Posttympanie process coösified with postglenoid ;

Incisors $\frac{1}{1}$; canine $\frac{0}{1}$; dermal horn median ; nasal septum not ossified . . . . *Rhinocerus.*

Incisors $\frac{0}{0}$; canine $\frac{0}{0}$; dermal horn median ; nasal septum ossified . . . . *Cœlodonta*

It can readily be seen that the genera above defined form a graduated series, the steps of which are measured principally by successive modifications of four different parts of the skeleton. These are, first, the reduction of the number of the toes of the anterior foot ; second, the reduction in the number and development of the canine and incisor teeth ; third, the degree of closure of the meatus auditorius externus below ; and, fourth, in the development of the dermal horns of the nose and its supports. While these characters have that tangible and measurable quantity which renders them available for generic diagnosis, there are others which possess a similar significance, and which I have noticed in an article published in the bulletin of the U. S. Geological Survey of the Territories for September 1879.

This series may be represented in genealogical relation, as follows :*

```
                                   Cœlodonta.
                                      /
               Rhinocerus.        Atelodus.
                     \              /
               Ceratorhinus.   Peraceras.
                        \        /
                        Aphelops.
                            |
Zalabis.                 Cœnopus.             Diceratherium.
```

The early type, which corresponds most nearly with *Cœnopus*, and which preceded both it and the *Aceratheria* in time, is the genus *Triplopus* Cope, which has left a species in the Upper Bridger of Wyoming. Here the incisors are probably $\frac{3}{3}$ and the canines $\frac{1}{1}$. This formula is that of the Eocene tapirs, where the normal numbers $\frac{3}{3}\ \frac{1}{1}$ prevail. *Triplopus* further differs in the primitive condition of the premolars above, which, as in the *Lophiodontidæ*, differ from the molars in their greater simplicity. Thus it is probable that tapiroids, probably *Lophiodontidæ*, gave origin to the *Rhinoceridæ*, as Marsh has suggested. And it is further altogether probable that the general type of dentition presented by the *Rhinoceridæ*, *Lophiodontidæ*, etc., which I have named the palæotheriodont, took its origin from the type which is intermediate between it and the bunodont, viz, the symborodont, as I have pointed out in an essay on this subject.

The first appearance of dermal horns was apparently in a pair placed transversely on the nasal bones, in species of Eocene *Lophiodontidæ* of the genus *Colonoceras*. The same character has been observed by Marsh in species of the Lower Miocene, which probably belong to the true *Rhinoceridæ*, and which he has called *Diceratherium*. This genus appears to have terminated the line exhibiting this structure, and the family in North America remained without horn. As we have seen, the types possessing the median horn arose in Europe, in the *Ceratorhinus schleiermacheri* of the Middle Miocene, and still survives.

*See American Naturalist, 1880, p. 611.

It may be observed in conclusion that a successive increase of size in the species of this line has taken place in North America with the advance of geologic time. Thus, their probable ancestors of the genus *Triplopus* were the least of all. The *Cœnopoda* of the White River formation were larger; the oldest *C. mite*, being the smallest. The *Aphelopes* of the Loup River or Upper Miocene formation were all larger, and were nearly equal to the large existing species.

TAPIRIDÆ.

The genera of this family are not numerous as yet. The oldest, *Listriodon*, appears in the Middle Miocene (Gers, France), and *Tapirus* is first found in the Upper Miocene (Epplesheim). The recent species of the family belong to *Tapirus* L., and *Elasmognathus* (Gill). A small species, the *Tapirulus hyracinus* Gerv., is from a bed at Perreal, France, which Pictet has identified with the gypsum of Paris (Oligocene). It is sometimes referred to this family, but is not sufficiently well known to determine its position. In America, *Listriodon*, or a genus which has not yet been distinguished from it, is found in the Miocenes.

The three genera are distinguished as follows:

Three anterior premolars different from fourth premolar
and true molars; last inferior molar with heel......... *Listriodon.*
One superior premolar different from true molars; no heel
of third inferior molar; nasal septum cartilaginous.... *Tapirus.*
Like *Tapirus*, but nasal septum osseous.................. *Elasmognathus.*

CHALICOTHERIIDÆ.

Gill; Cope, American Naturalist, 1881, p. 340.

This family had numerous representatives during Eocene time, and a few species of *Chalicotherium* extended into Miocene time. The boundaries which separate the family from the *Lophiodontidæ* on the one hand and the *Menodontidæ* on the other, are not always easy to determine. From the former the symmetrically developed external Vs of the superior molars, and the double Vs of the inferior molars distinguish it. Yet in *Rhagatherium* the external Vs are not so well distinguished as in other *Chalicotheriidæ;* and in *Propalæotherium*, the anterior cingular cusp produces a part of the assymmetry found in the *Lophiodontidæ*. The character of the double inner cusps of the superior premolars, which distinguish the *Menodontidæ*, is only applicable to the last premolar in *Diplacodon* of the latter, while a trace of the additional cusp of this tooth is found in the Chalicotheroid *Nestoritherium*.

In using the following table it must be borne in mind that the number of the toes has been determined in a very few of the genera. Should any of them prove to have but three digits on the anterior foot, such genera must be referred to a new family intermediate between this one and the *Palæotheriidæ*.

I. Internal cones of superior molars separate from external lobes.

A. Cusps of inferior molars not completely united ;

a. External lobes of superior molars more or less conic.

Inferior premolars III and IV compressed, three lobed ; a diastema both behind and before P-m. II.............................*Rhagatherium.*

AA. Cusps of inferior molars united into two Vs.

α. Incisors present.

β. No diastema in front of second inferior premolar.

Second premolar without inner lobe ; last molar with one inner cone..... *Leurocephalus.*

Second premolar with inner cone ; last superior molar with an inner cone..*Palæosyops.*

Second premolar with inner cone ; last superior molar with two inner cones..*Limnohyus.*

ββ. A diastema in front of second inferior premolar.

Two inner cones of last superior molar..................*Lambdotherium.*

αα. Incisors absent from both jaws.

Last superior molar with one internal cone...............*Nestoritherium.*

II. One or both internal cusps of superior molars united with the external lobes by cross-crests.

α. External cusps of superior molars more or less conic ;

An anteroexternal cingular cusp.........................*Propalæotherium.*

αα. External lobes of superior molars, inflected Vs.

β. No crescentic inner lobes.

No intermediate lobes...................................*Chalicotherium.*

ββ. One or more lobes of each molar crescentic.

Intermediate lobes, and one internal cone of superior molars............. *Meniscotherium.*

The following regions have thus far furnished species of the above-mentioned genera :

Europe—*Rhagatherium, Propalæotherium, Chalicotherium.*

N. America—*Leurocephalus, Palæosyops, Limnohyus, Lambdotherium, Meniscotherium.*

Asia—*Nestoritherium.*

Of the American genera, *Leurocephalus* S. S. & O. has been found by the Princeton exploring expedition of 1877 in the Bridger formation, but I have not met with it myself. *Meniscotherium* Cope, is known from a single species found by myself in the Wasatch formation of New Mexico, and described in my report to Capt. G. M. Wheeler (1877).

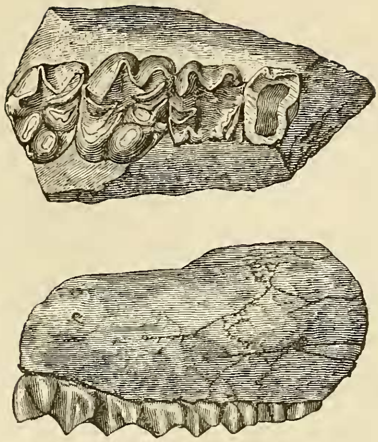


FIG. 2. Part of right maxillary bone of *Meniscotherium chamense* Cope, from the Wasatch bed of New Mexico. From Report Capt. G. M. Wheeler, IV, ii, Pl. LXVI.

MENODONTIDÆ.

The known genera of this family are not numerous. They are defined as follows:

I. Vs of inferior molars probably incomplete; superior molars with intermediate tubercles.

Internal cusps of superior molars well separated................*Acoëssus.*

II. Inferior molars with the crowns thrown into two Vs; superior molars without intermediate tubercles.

a. Last superior premolar only with two inner tubercles.

Incisors present..*Diplacodon.*

aa. All the superior premolars with two interior cusps.

Six inferior incisors, canines very large........................*Dœodon.*

Six inferior incisors; canines very small ....*Menodus.*

No inferior, and four small superior incisors; canine very small.......... *Symborodon.*

The first appearance of this family was in the Early Eocene in the genus *Acoëssus* Cope, which was a cotemporary of *Hyracotherium,* and which it resembles in some respects. Its typical species was called *Hyracotherium siderolithicum* by Pictet, its describer, but Kowalewsky has already expressed the opinion that the species does not belong to that genus. It is from the Lower Eocene of Mauremont, Switzerland. The remaining genera are, as yet, American, excepting one, which is represented by an Austrian species, not yet well known. *Diplacodon,* in its simpler premolars, approaches the *Chalicotheriidæ,* and is the oldest of the American genera. It is from the Uinta or Upper Eocene. *Menodus* and *Symborodon,* which include some species of gigantic size, belong in the White river or Oligocene, while *Dœodon* has so far only been obtained from the Truckee or Upper Oligocene.

MACRAUCHENIIDÆ.

But one genus of this family is known at the present time. The following are the dental characters of *Macrauchenia*. Formula: I. $\frac{3}{3}$; C. $\frac{1}{1}$; P.m. $\frac{4}{4}$; M. $\frac{3}{3}$, forming an uninterrupted series. The superior molars present two external Vs, and two oblique transverse crests, somewhat as in *Palæotherium*. The spinous foramina pierce the neural arch of the dorsal vertebræ (Gervais). There is no intertrochlear crest of the humerus, but the carpal facets of the radius are well distinguished. The internal malleolus is small, but the fibular malleolus is coössified with the tibia at an early age, and articulates with the calcaneum. The trochlea of the astralagus is well developed. The lateral digits are large, and the distal keels of the metapodials are continued on the anterior face of the condyle.

The position indicated by the above characters is a remarkable one. The uninterrupted dental series and the absence of intertrochlear humeral crest, are primitive features among ungulate *Mammalia*. The radiocarpal articulation is facetted as in higher ungulates, but lacks the inferior condyloid face of those types. The completeness of the metapodial distal keels is a feature of high specialization, only seen in the *Equidæ* of this order. The coössification of the external malleolus is also a character peculiar to the *Equidæ* among the *Perissodactyla*. There are two other characters which are not elsewhere found in this order, viz: the articulation of the fibula with the calcaneum, and the absence of the vertebrarterial canal. The former belongs to the *Artiodactyla* generally, and to the Proboscidæ, and the latter to the ruminant family of the *Camelidæ*. Thus the *Macraucheniidæ* stand out as one of the most distinct of the families of the *Perissodactyla*, and one to which we may anticipate considerable accessions in future.

But two species of *Macrauchenia* are known, a larger, *M. patachonica*, and a smaller, *M. baliviensis*, both from the Pliocene formation of South America.

PALÆOTHERIIDÆ.

This family has been already defined on page 378. In its complex premolar teeth, which in the upper jaw resemble the molars in composition, it shows an advance over the *Chalicotheroid* and other genera of the Lower Eocene. In fact, it has not been found in the Lower Eocene, but commences in the Upper Eocene in the genera *Palæotherium* and *Paloplotherium*. Thence it extends to the very summit of the Miocene, and may even occur in the European Pliocene (*Protohippus*). Its members exhibit considerable range of variation in the details of the teeth and feet, but no striking break of family importance occurs. The most noteworthy interruption is that which is found between the *Palæotherinæ* and *Hippotheriinæ*, where there is a change in the form of the proximal extremity of the humerus from a tapiroid to a horse-like form, and a modification of similar significance in the molar teeth, by the addition of a deposit of cementum.

The characters of the genera are as follows :

I. *Palæotheriinæ.* Bicipital groove of humerus simple ; teeth without cementum.

a. One or more internal tubercles of superior molars distinct.

External Vs of superior molars not well distinguished externally......... *Anchilophus.*

External Vs separated by a vertical rib ; intermediate tubercles not connecting fore and aft.................................... *Paloplotherium.*

External Vs separated ; intermediate tubercles extended fore and aft...... *Anchippus.*

aa. Internal tubercles of superior true molars continuous with the transverse ridges.

Inferior molars with two Vs only; lateral toes large......... *Palæotherium.*

Inferior molars with distinct internal tubercles ; lateral toes small ; a short fifth metacarpal.................................... *Mesohippus.*

Inferior molars with cusps at the inner extremities of the Vs ; lateral toes small; no fifth metacarpal............................ *Anchitherium,*

II. *Hippotheriinæ.* Bicipital grooove of humerus double; molars with cement in the valleys. (Intermediate tubercles connected fore and aft.)

a. One or more internal tubercles of superior molars distinct.

Inner lobes of inferior molars enlarged...................... *Hippotherium.*

aa. Internal tubercles of molars not distinct.

Inner lobes of inferior molars enlarged...................... *Protohippus.*

The genera of this family are generally of less antiquity than those of the *Chalicotheriidæ*, and they range from the Middle Eocene to the Pliocene. *Paloplotherium* is found in the Middle Eocene, and is, as might have been anticipated, more nearly allied to the *Chalicotheriidæ* than any other genus of this family. *Propalæotherium* is not far removed from it. *Anchilophus* is upper Eocene, and is allied to the genus just named, and also to *Pachynolophus* among the *Lophiodontidæ.* These early genera constitute by their similarity, the bond of connection between the three families which in their later and specialized forms are very different from each other. *Palæotherium* is chiefly found in the Upper Eocene, and *Mesohippus* is only known from the White river or Oligocene, an age between Eocene and Miocene. *Anchitherium* commences in the Middle Miocene and has *Anchippus* for a cotemporary. *Hippotherium* existed only in the latter part of the Miocene Epoch, consistently with the greatly specialized structure of its limbs and teeth, and the nearly allied *Protohippus* lived with it; while in Europe a species with the same type of molar teeth is found in the Pliocene epoch (Forsyth-Major). These forms were cotemporary with the *Equidæ,* which outlived them. They have many points of resemblance to that family, but nevertheless remain at a considerable interval from them in the structure of the feet.

The geographical distribution of these genera, so far as present knowledge shows, is as follows:

North America alone—*Mesohippus, Anchippus.*

North America and Europe—*Anchitherium, Hippotherium, Protohippus.*

Europe only—*Anchilophus, Paloplotherium, Palæotherium.*

EQUIDÆ.

The two genera of this family are distinguished as follows:

Internal lobes of superior molars subequal.................. *Hippidium.*

Anterior internal lobes of superior molars much larger than the posterior.. *Equus.*

The genus *Hippidium* is extinct, and its species have been thus far found only in North and South America, in beds of Pliocene age. *Equus* made its appearance during the same period, and is represented by several existing species.

Besides the reduction in the number of digits, which is carried farther here than in any other family of *Mammalia,* there are several other characteristics of specialization. Thus in the dentition, the spaces between the tubercles are filled with cementum. These valleys are generally deep, owing to the prismatic forms of the molars. The cups of the incisors are completely developed, and also filled with cementum. There are two bicipital grooves of the humerus. The preceding characters are also found in the *Hippotheriinæ* of the *Palæotheriidæ.*

The *Equidæ* adds another evidence of greater specialization than the latter group in the structure of its feet, *i. e.,* the distal metapodial keels are completed forwards, as in most ruminants.

The similarity of the modifications which have supervened on the Artiodactyle and Perissodactyle lines in attaining their most specialized extreme has often been noticed. I repeat them here in tabular form in three columns. These show (Table I) the modifications in which the *Equidæ* and *Bovidæ* are identical or nearly so, which place them at the heads of their respective orders; Table II, those in which the *Equidæ* are the more specialized of the two; and Table III, those in which the *Bovidæ* displays the highest differentiation.

	Table I.	Table II.	Table III.
1	Obliteration of first premolars.	Cupping of incisor teeth.	Absence of superior incisors.
2	Selenodont and prismatic character of molars.	Deposit of cementum in teeth	Trough-shape of odontoid.
3	Flattened odontoid process.	Double bicipital groove of humerus.	Greater involution of lumbar prezygapophysis.
4	Reduction and coössification of ulna.	Reduction of metapodials to one.	Fibular articulation of calcaneum.
5	Intertrochlear crest of humerus.		Distal ginglymus of astragalus.
6	Distal facets of radius.		
7	Involution of lumbar prezygapophyses.		
8	Elongate sacrum.		
9	Shaft of fibula atrophied, and its distal extremity coössified to tibia.		
10	Reduction in number of digits.		
11	Anterior extension of carinæ of metapodial bones.		